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IN THREE SECTIONS

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EDITORIAL DEPARTMENT NOTE

Cost accountants have long realized that in a competitive society the concern which included in its costs large amounts of expense due to excess and unused capacity was at a decided disadvantage in competing with the concern whose productive capacity was more closely related to demand. Such terms as normal capacity, idle capacity, and excess capacity have become quite familiar to the industrial accountant, and the use of normal or average utilization in the application of manufacturing burden has been generally accepted. But the problem in pre-depression days was quite simple compared with the many questions involving plant capacity which have been brought to the fore by the depression.

With more excess capacity than ever before, with idle capacity which may become excess capacity before business improves sufficiently to justify its use, and with numerous selling-below-cost provisions and allottment agreements based on plant capacity figures, there seems need for more consideration and study of this important subject.

We are publishing this month a rather extensive article dealing with the whole problem of plant capacity. The author of this paper, Charles C. James, was born in Illinois near St. Louis, Missouri. His first practical experience found him in the accounting and operating departments of the St. Louis and San Francisco Railroad, of which he was Assistant Superintendent of Construction on the line between Memphis and St. Louis. In 1909 he became a member of the original staff of examiners of railroad accounts for the Interstate Commerce Commission. Following this experience, he has been engaged with a number of large organizations, including the Southern Pacific Railroad, the Merchants Shipbuilding Corp., Merritt-Chapman & Scott Corp., William Cramp & Sons Ship and Engine Building Co., Cramp-Morris Industrials, Inc., and the Westinghouse Electric and Manufacturing Co. Since 1931 he has been associated as Consulting Accountant with Stevenson, Jordan & Harrison. For many years Mr. James has been active in the affairs of our Association and has often appeared on the programs of our chapters and annual conventions.

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MEASURING PLANT CAPACITY

By Charles C. James,

Stevenson, Jordan & Harrison, New York, N. Y.

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I. INTRODUCTION

The problem of relating plant capacity to potential needs is of timely importance and interest both from the point of view of the individual manufacturer in figuring his own costs and administering his own business and from the standpoint of industrial regulation of business through plans to equalize production with demand, which we may now be facing.

The purpose of this article is, first, to discuss capacity in its different forms or kinds, second, to show its importance in the

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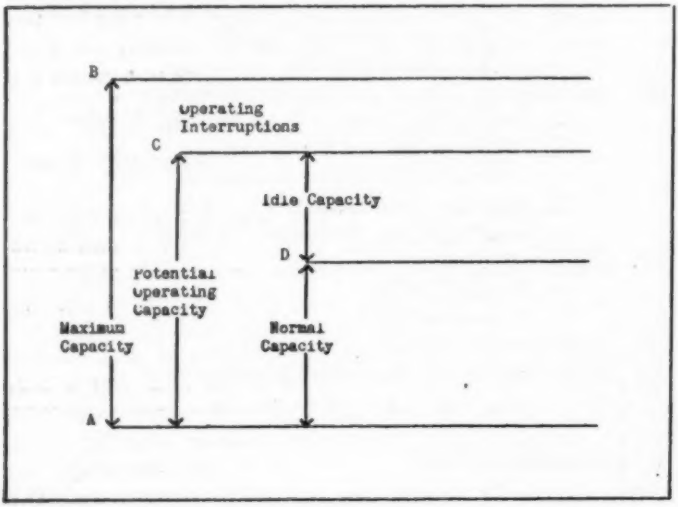
forming of efficient managemental policies, third, to suggest methods of measuring capacity and, lastly, to consider its proper handling in accounting procedures.

II. KINDS OF CAPACITY

As soon as one begins to study the nature of capacity it is found to exist in many different forms. Accepted parlance already embraces such familiar terms as potential operating capacity, normal capacity, and idle capacity. At the International Cost Conference held in Syracuse, N. Y., in 1930, Edward P. Rush[1] graphically presented the difficulties of actually utilizing the maximum physical capacity of a plant in a diagram, of which the following is a slightly modified version:



In order to keep our further discussions clear, a listing of the several classes of utilization and non-utilization of maximum capacity will be helpful. Let us therefore attempt some concrete definitions covering all the different kinds of capacity.

Before considering the various kinds of capacity, however, let us

[1] See Year Book of National Association of Cost Accountants, 1930, p. 167.

note that capacity must always be expressed in terms of a given period of time. We are prone to look upon capacity as a snapshot taken at a given moment in order to show just how much of the physical plant is in use. But the per cent of usage varies from one stage of the business cycle to another, from one season to another, from one month to another, and even from day to day. In defining various concepts of capital we must be careful to indicate whether we are referring to an average over a period of time or an actual figure for the period of time in question.

A. *Plant Capacity as an Average*

In speaking of maximum physical capacity, potential operating capacity, normal capacity and idle capacity, it is desirable to think of an average taken over a sufficiently long period of time to level out the peaks and valleys of ordinary business. While the first two of these concepts may as well be expressed as simple figures applying for any selected period of time such as a week or a month, it is preferable to think of them as averages in order that they may be related to the other concepts. This makes it possible for us to speak of normal and idle capacity in terms of physical capacity or operating capacity.

(1) *Maximum Physical Capacity.* The physical capacity of a plant to product commodities or services when not limited by human factors and external influences may be described as its maximum physical capacity. In the conceptual diagram on page 354 this is represented by the distance between lines A and B.

(2) *Potential Operating Capacity.* This is the full, practical utilization of the physical plant indicating that a full load is being carried. In determining this capacity, allowances must be made for the unavoidable operating interruptions such as time lost for repairs, waits, breaks, set-ups, make-readies and clear-aways, machine failures, organization slips, unsatisfactory materials, delays in deliveries of raw materials from suppliers, labor fall-downs and absences. Since we are thinking of average potential operating capacity, actual tests measuring the influence of these lost time factors should cover a sufficient period of time to give an average expectancy. In the diagram on page 354 this concept is represented by the distance between lines A and C.

The General Electric Company's overall time analysis in its Erie

Works when in full operation showed actual cutting time of only 23% for the average of all machines engaged in this work.[2] Even on a conveyor under straight-line mass production 100% results are not attainable.

(3) *Normal Capacity* is the utilization of physical plant that is necessary to meet the *average* commercial demands over a period of time long enough to level out the peaks which come with seasonal and cyclical variations. In the diagram on page 354 this is represented by the distance between lines A and D.

If, as is usually the case, an enterprise must content itself with its fair proportion of the production of the industry of which it is a part, and it is already equipped to meet supernormal demands, then its normal capacity is determined by average sales expectancy.

Even if a monopoly exists, as in the case of aluminum, normal utilization will be under potential operating capacity. This is obviously true because every slowing down in demand which lasts long enough to reduce operations below the practical maximum would have the effect of bringing the average below the practical maximum.

The average practical use of plant and equipment for a considerable length of time must, therefore, determine its normal use per annum, per week, per day, per hour and per minute.

An extreme example is found in the machine tool builders' industry. As Clark points out,[3] if we take *average* replacements requirements of their customers as a base of 100, actual demands for new equipment fluctuate from plus 300 to minus 100. While the machine tool builders never completely stop operations, nor are they equipped to meet super-normal demands with prompt deliveries, the average use of their manufacturing facilities ranges between 50% and 60% of potential capacity. From this it follows that a machine tool builder is operating at normal whenever he is turning out a little over half of what he is equipped to produce.

(4) *Idle Capacity* represents the average unutilized portion of the plant and equipment over a long enough period of time to level out the peaks and valleys which come with seasonal and cyclical

[2] See Mogensen, Allan H., *Common Sense Applied to Motion and Time Study*, McGraw-Hill Book Co., New York, 1932, p. 183.

[3] See Clark, J. Maurice, *Economics of Overhead Costs*, University of Chicago Press, Chicago, 1923, pp. 390-394.

variations. In the diagram it is represented by the distance from line D to line C. It should be noticed that normal capacity plus idle capacity equals potential operating capacity. The concepts of capacity so far discussed are all interrelated and are all defined as averages over a period of time. While these averages are based on experience or estimates covering a long enough time to level out the season and cyclical variations they may be expressed in terms of any desired period of time. Thus we may speak of the normal capacity of a plant per week, per month or per year, realizing that the figure mentioned is an average based on experience on estimates covering a period of five years, ten years, or whatever period is used for the purpose of leveling out cyclical variations.

B. *Actual Plant Capacity for a Specific Period of Time*

In addition to stating capacity as a weekly or monthly average calculated over a relatively long period of time, we may state it as an actual figure for the particular period of time under consideration. Thus the potential operating capacity of a plant for a particularly favorable week may be 1,000 units, while the average weekly operating capacity for a longer period may be 800 units. Seasonal influences and major interruption will tend to bring down the average for the longer period. Peak demand capacity and excess capacity are examples of capacity measured for a specific period of time.

(1) *Peak Demand Capacity* is the utilization of plant and equipment during a specified period of time to meet the maximum commercial demands for the products of the plant. This peak demand capacity may be more or less than potential operating capacity. If it is greater, the peak demand must be met through overtime operations, extra shifts or delays in deliveries. If the capacity required to meet peak demand is less than potential operating capacity the difference represents excess capacity.

(2) *Excess Capacity* may, therefore be defined as operating capacity which is over and above peak demand capacity. It is that part of idle capacity, which is not utilized even at the time of maximum demand.

Excess Capacity results from two conditions: (1) Capacity to produce more than the company can reasonably hope to sell; (2)

Unbalanced machines or processes. Each of these will be considered in turn.

(1) Capacity to produce more than can be sold characterizes the condition of many present-day enterprises. By forces coming from many origins they have been led into equipping themselves to supply a continually increasing, and to a large extent, a speculative demand. They now find amid much grief that they have overrun their market.

It is not wise to assume that this condition will correct itself within the economical life time of the excess equipment. If and when general demands have reached the normal secular trend, unless a war intervenes with its quickening demand, the march of technology will have outmoded even the best of today's machinery and tools.

As it is always the least economical equipment that is laid by to await possible future requirements, it is fair to say that all equipment which is not in use today should be looked on as having doubtful worth. Its present book value should therefore be reduced to a nominal figure, even though this may require an accompanying drastic revision of the capital structure of the enterprise. There is no place where the need for this is more outstanding than with certain of our railroads. The Florida East Coast was double-tracked down the Florida coast during the Florida land boom. It is now physically capable of handling more traffic than it can ever hope to secure. Paralleled by excellent motor highways, its rates cannot be made high enough to yield a return on the cost of its property. It has made an improvident investment that should be deducted from the book value of its capital stock. Moreover, the cost of maintaining its excessive facilities and the increased taxation they entail should be excluded from account in arriving at the net railway operating income of the property.

In somewhat less striking fashion all of the railroads of the country have in their property accounts the cost of facilities that have lost their utility value. It cannot be restored by any process of rate revision nor by any feasible equalization of taxation as between the railroads and the competing buses and trucks that use the public highways. In this situation the railroads are just out of luck and the sooner they yield to the inevitable the better. Other lines of industry will do well to profit by their example and avoid the

temptation of trying to carry dead horses on the backs of live ones. The march of progress is such that if we would keep up with the procession we must not hesitate to bury our mistakes by the wayside.

(2) Unbalanced machines and processes produce another type of excess capacity, in the part-time idleness of certain facilities whose productive capacity exceeds that of the rest of the equipment in the plant with which their output must synchronize, or which can be operated economically only during periods of peak demand. Machines with high power costs and high operator wages, which can produce economies only when used on large volume operations, quickly become excess equipment when volume falls off and price and wage levels fall. A valve manufacturer, for instance, has a large boring mill that he uses infrequently because orders for extra large size valves are now received but seldom. The machine therefore is now more costly on the small amount of work it has to do than even if hand tools were used, and to that extent at least the excess capacity it represents is a burden on the manufacturer.

Frequently, it may be necessary, or even more economical, to keep such equipment than to replace it. If the disparity in cost, however, is great, the excess expense of continuing to use uneconomical equipment should be excluded from costs of product and from operating expenses and be treated as a deduction from income.

Unhappily, such deductions have been made in published reports of large corporations under the caption "idle plant expense." This is misleading for as has been said, idle equipment is inherent in every industry at all times when not needed to meet peak demands. The correct terminology is "excess plant expense" or "excess capacity expense" and is that particular kind of idle capacity expense which the potential needs of the enterprise cannot be expected to utilize.

Excess Plant Expenses Should Be Eliminated

Excess plant expenses for the most part represent the current cost of past mistakes of administrative judgment. They should not be viewed complacently as an unavoidable drag on current profits. Before accepting excess capacity as an unavoidable condition of the business the resourceful executive will exhaust the possibilities

of undertaking new activities that can be turned out in the otherwise idle time of the machines. Quite often it is found cheaper to make than to buy certain parts. Again products coming from otherwise idle equipment can be sold on a narrow margin over out-of-pocket costs, because they reduce unabsorbed overhead commonly called "volume variance." But not infrequently such undertakings turn out to be unwise and careful circumspection should be the prerequisite to embarking on them. As this is a matter in the field of business discretion outside the scope of the subject of this treatise, it is sufficient here to call attention to the fact that there are advantages and disadvantages to be considered, and to say that the common tendency is to over-estimate the advantages to be derived from so-called fill-in work taken to try to absorb the expense of idle capacity that the primary products of the enterprise cannot presently carry.

Some one of the enterprise's principal executives should be delegated with the duty to find out how excess capacity expense may be eliminated. If he can find ways in which the excess capacity can be put to profitable use in processing new lines of output, well and good. If not, the probabilities are that a large part of the surplus equipment itself should be scrapped. Certainly its cost should be dealt with as a capital loss and unequivocably written out of the net worth of the business in its statements to its stockholders. Until this is done it is the duty of the accountant to set its carrying expense out where the management cannot ignore it.

Cost of Products Should Be Computed at Normal Capacity

Now that we have surveyed the various types of capacity there remains to be emphasized the fact that normal capacity is the one directly related to costs. (Our normal mean temperature in New York during January is 34°F, and we must, therefore, figure our fuel budget at enough to maintain an average spread of 36°F between out-of-doors and inside, although the outside temperature may seldom register 34°F for long on any January day, and the actual fuel consumption for any hour, day, or week, or for any particular January, may be away off from our average allowance).

Let it be said once and for all that cost accounting must concern itself with many questions which cannot be answered wholly from accounting records. Cost of products, for example, are seldom

correctly reckoned merely by dividing units of products into dollars of expenditure for any given period. Unit costs of standard items should be constant in season and out through good times and bad, except only as they are altered by fluctuations in prices paid for raw materials and in rates of wages paid for labor.

Hourly, daily, weekly, seasonal, and cyclical variations in plant activity must be ironed out of our production figures before we factor them in cost computations.

Expenses of maintaining a plant in readiness to serve must likewise be adjusted to economical requirements before they may be accepted as correct factors in figuring true costs.

Let it be noted in passing that what is said here should not be interpreted as advocating that all expenses of readiness to serve in excess of those required to meet normal demands should be excluded from true costs. It is only when we maintain facilities in excess of those required to meet maximum commercial demands that we must rectify our plant expenditures down to economical requirements. The practical application of this may be seen readily enough in the case of electric power plants, which must be equipped to meet peak loads that come at certain hours of the day and usually are more than double the average load on the line. Therefore the cost per kilowatt hour must be obtained by dividing the average load into the expense of maintaining the required service facilities, except so far as special peak requirements can be segregated and specially charged with the differential expenses their demands entail.

The determination of readiness-to-serve requirements may in certain industries involve consideration of varying factors. For example, an industry using a perishable product as its raw material may have to take into account the deterioration which results from delay in processing. Eugene L. Grant (*Principles of Engineering Economy,* Ronald Press Company, New York, pp 143-144) presents a problem of this kind from the sugar beet industry:

"For instance, the economical capacity of a beet sugar factory serving any region, depends not only on the average beet production of that region, but is also greatly influenced by the losses which occur in sugar content of beets in storage. The beets are all harvested in a few weeks and the sugar is manufactured in a 'campaign' of relatively short duration. The larger the capacity of the

factory, the shorter the storage time for the beets and the less the loss of sugar content in storage. On the other hand, the larger the factory, the greater are the investment charges of interest, depreciation and taxes.

"Suppose that it is desired to determine the economical size of factory to convert an average annual crop of 240,000 tons of beets. The following simplifying assumptions will be made: Beets lose 1.1 lb. of sugar per ton per day of storage, and the sugar content lost in storage is worth 3¢ per pound.

The crop is harvested so that it comes to the sugar company uniformly throughout a 50-day period. (Thus a factory with a sufficient capacity to convert the entire crop in 50 days would have no beet storage which would be preventable by increasing factory capacity.)

Annual depreciation on plant investment averages 7% and taxes and insurance are 3%.

A 15% return is required to justify an extra investment.

For capacities of 1,200, 1,600, 2,400, 3,200, and 4,800 tons of beets per day, the required plant investments are respectively 1.2, 1.5, 2.1, 2.6, and 3.6 millions of dollars.

Operating costs per ton of beets will be the same regardless of factory size; the economies of larger units will be neutralized by the savings due to more continuous operation of the smaller-sized factories.

Interest and storage costs on inventories of beets and of sugar may be neglected.

Under these assumptions the cost comparison may be as shown in Table 9.

The average storage time of beets (in line C) is half the difference between the length of the campaign and 50 days. The preventable sugar loss in pounds is secured by multiplying the loss per ton per day (1.1) by 240,000 by the average days of storage. The other figures in the table should be self-explanatory.

The table indicates the factory of 2,400 tons per day capacity as the largest one which meets the requirements of a 15% return or better on an extra investment.

If a beet sugar factory already built is too large or too small for the most economical operation, its costs are distorted unless they

TABLE 9. ECONOMICAL CAPACITY OF BEET SUGAR FACTORY FOR CROP OF 240,000 TONS

A.	Capacity of factory—tons per day	1,200	1,600	2,400	3,200	4,800
B.	Length of campaign—days	200	150	100	75	50
C.	Average storage time of beets—days	75	50	25	12.5	0
D.	Preventable sugar loss in storage—tons	9,900	6,600	3,300	1,650	0
E.	Value of sugar lost in storage	$594,000	$396,000	$198,000	$99,000	0
F.	Investment in factory	$1,200,000	$1,500,000	$2,100,000	$2,600,000	$3,600,000
G.	Depreciation, taxes and insurance (10%)	$120,000	$150,000	$210,000	$260,000	$360,000
H.	Annual costs variable with capacity (E + G)	$714,000	$546,000	$408,000	$359,000	$360,000
I.	Annual saving from extra capacity		$168,000	$138,000	$49,000	Negative
J.	Extra investment in extra capacity		$300,000	$600,000	$500,000	$1,000,000
K.	Rate of return on extra investment		56.0%	23.0%	9.8%	Negative

are based not on operating the plant as it is but on the plant that ought to have been."

A consideration of this sort leads us far afield, especially if costs, as in many N. R. A. Codes, are to determine minimum sales prices. We shall hear more and more of questions such as these if the attempt is not abandoned by industry of demanding governmental protection against losses from miscalculated investments.

Another type of idle capacity is *"undeveloped" idle capacity.* Power companies, railroads and the like carry land, water sites and other properties with the sole purpose of developing them in the future. To bring such capacity into the operating field, demands a future development. In the meanwhile the carrying expenses should not be allowed to find their way into costs of processing current output.

The same general principle holds true for unutilized factory buildings and sites, and even in some degree to utilized space in occupied buildings.

These definitions given above will take on a much more practical bent as we discuss the actual value that comes with an analysis of plant capacity.

III. PURPOSES AND USES OF CAPACITY DETERMINATION.

Let us take up now the real returns that come with the determination of plant capacity. They can be treated under five fields of usefulness.

1. Establishing Standard Costs for Price-making.
2. Planning Sales and Production.
3. Determining the Profit-Realization Point.
4. Providing Plant Balance.
5. Assisting in Allotments of Volume.

Each of these are taken up in turn.

1. Establishing Standard Costs for Price-Making

If we may say that all productive enterprises have been brought into being and continue to exist to meet potential market demands, then normal capacity as defined above is the correct basis to be used in determining standard processing costs. This presupposes

that the factory must serve the needs of the industry of which it is a part as such needs are developed or disclosed by the sales department. Under this condition normal output must be determined by the long-time average distribution of products as forecast from sales analysis and market research. This is said to be the basis on which the General Motors Corp. computes its costs and prices its products.[4]

There is an alternative which is said to be typified in the policy of the Ford Motor Co. This is based on the premise that the present plant and equipment represent the controlling capacity of the enterprise. Costs are computed and prices set which are derived from the full physical utilization of the facilities that have been provided. It is the responsibility of the sales department to obtain distribution accordingly.

In the one case the factory serves the demands of the sales department. In the other the sales department serves the factory. The choice between the two must be determined to fit the condition which obtains in the individual enterprise. It should be definitely one way or the other, as no business can serve two masters.

If business men could foresee the future and confidently predict the so-called secular trends of their own enterprises, it would be safe for them to predetermine normal capacity projected over an economic cycle, which may or may not be a period of ten years. But forecasts have so far not attained to any such trustworthiness. Until they do so, if ever, business prudence dictates that they be revised annually.

All business is based upon some degree of confidence in the long future. Over-confidence is the rule rather than the exception. Nothing seems normal unless it is very good.

The annual resurvey of normal capacity and peak-demand capacity, as of other objectives, should be made against a tabulation of the results of each year of the past as far back as they are of record. We have so far no way of judging the future except in the light of the past. But the recent past is likely to prove too extraordinary for future guidance, and all past experience must be pro-

[4] For an elaboration of the procedure of computing costs and setting prices on basis of sales demands, see the author's paper entitled "What Use Can the Sales Manager Make of Manufacturing Costs?", National Association of Cost Accountants Bulletin, October 1, 1932.

jected into the future with circumspection and imagination derived from our present best judgment of future market trends, or we shall plan to travel in a circle when we are actually headed into new and different paths, paths on which we shall find our competitors have blazed a way ahead of us.

I happen to know of three recently completed market surveys, two of which quite independently of each other, agree upon the level of 1926 as the normal for the future. The third has established the level of 1930 as the normal in its field. One has forecast a return to normal by 1935, another by 1936, while the third expresses no opinion on that point. None of the three looks with sufficient confidence upon its own conclusions to be willing to let me publish its name, yet each is planning its own future marketing and operating policies on its own forecast. There is no other way.

2. Planning Sales and Production

The importance of coordinating sales and production has received major emphasis in a large volume of literature and discussion. From these treatments one readily gleans the thought that the sales division is selling operating capacity just as truly as it sells goods.

To grasp the significance of this relation between sales and plant capacity it might be well to look at two dissimilar situations in our industrial landscape. Contrast the situation, if you will, during the war when capacity was inadequate with these days of depression when capacity is far above needs. Mr. Wm, O. Lichtner well covers the situation during War days:[5]

"In a great many factories during this entire period the entire product of the factory was spoken for months in advance and the salesmen could not continue to sell not because they lacked selling ability or because they could not stimulate demand, but because the plant capacity was already used up. In some cases this was due to the limited amount of equipment, but probably in more cases it was due to lack of labor, or of material on which to work—all three of which factors limit plant capacity. During the war many salesmen realized for the first time that by selling standard lines for which material was on hand, or on which the amount of labor was

[5] *Time Study and Job Analysis*, pp. 329, 340.

less, instead of booming the more easily selling specialties—in other words, by paying attention to manufacturing needs—they could in a sense actually increase plant capacity. Furthermore, any unsold capacity or idle equipment is a drag on the rest of the plant. The total (fixed) overhead, which remains the same, cannot be distributed over so many items, and therefore the cost per unit rises. In a competitive market, where the prices are practically fixed, loss is therefore sure to follow unsold capacity. Accordingly it may actually be cheaper to sell some line at what superficially appears a loss in order to avoid a greater loss from unsold capacity. It does not necessarily follow that when the largest volume of product is sold, the cost of manufacturing is least and the profits the largest."

Granted thus that capacity consideration is important during the proverbial "seven years of fat" how much more important is it during our present years of lean.

The last four years bear witness to a surplus of capacity in practically every field of industrial endeavor. Sales are not limited by inadequacy of capacity but by lack of buying power. Sales emphasis, however, must be so guided as to insure the working of the greatest amount of capacity even though it means a greater effort on the sales force who are ever prone to sell the easiest line regardless of the capacity costs that lurk in the manufacturing process.

From this it follows that, unless care is given to projecting lines of sales in terms of operating capacity, costs will involve uncollectible charges from idle capacity where utilization is uneconomically low, while other processing operations will demand serious overpressures on other divisions of the plant.

3. *Determining the Profit-Realization Point*

The concept of "profit-realization" or "break-even" point is one of the most useful that has entered the practice and procedure of modern budgeting. In practical application it calls for the determination of the point where income and expense balance. Below that point there is a loss; above that point, a profit. It is clearly evident that this profit-realization point, which is usually expressed in sales volume, corresponds to a certain amount of product at certain prices. This volume of product in turn is a certain deter-

minable part of plant capacity. That is to say, from our capacity point of view, *the plant is burdened* in each of its divisions with fixed charges which in turn demand a definite output in order to supply a volume of product whose sales income will exactly balance expenditures.

Volume of production necessarily is affected by price levels that are influenced by outside competition. Lower prices may increase production volume, indeed, they may bring utilization very close to operating capacity and yet because of low prices the break-even point may become so high that profits are not realized. In contrast our price level may be too high with corresponding smaller volumes and greater idle capacity costs. Here again we find the break-even point too high for a favorable profit condition.

This interplay of prices, costs, volumes and capacities calls for nice measurement on the part of management.[6]

4. Providing Plant Balance

In the main this calls for the proper scheduling of orders through the plant. Engineering studies which lead to a careful consideration of length of runs, set-up costs, and machine tool layouts are of great importance in reaching an improved condition where the plant is in better balance with production. Such studies should lead to the reduction of many idle capacity costs.

For the same reason that the strength of a chain is the strength of its weakest link, the maximum production of a shop is the maximum production of its "bottleneck." In a steel mill, for example, the speed and capacity of the rolls usually control the output of the furnaces and the volume of finishing operations.

The production of individual departments, machines, or processes must be severally synchronized with the aggregate output of all. To illustrate: If the overall capacity of an entire plant be 80% of maximum capacity, this is the percentage that will apply to its key operations. Feeder operations will average more or less, accordingly as they are overbalanced or underbalanced. For example, an automatic screw machine might have capacity for producing

[6] For an elaboration of the method of computing "break-even" points see paper presented at the "Twelfth International Cost Conference" by E. S. La Rose, National Association of Cost Accountants Year Book 1931, pp. 206-210.

double the number of screws that could be used in assembling the factory's present product. Its normal capacity would then be half that of the overall average, unless a part of its production could be sold outside. Finishing processes must be "normalized" by similarly relating them to controlling operatings, where they themselves are not the controlling factors.

Where a battery of like purpose machines are available for service, they make up a production or cost center. Their aggregate normal production determines their normal capacity[7] as an integral unit, with differing individual standards only so far as necessary to permit of more intensive use of the more economical or efficient units.

5. Capacity and Allotment of Volume.

Coming under N. R. A. Codes, A. A. A. agreements, and other government restrictions, is the ever present problem of production control. Any limitation of volume, and any allotment of the curtailed volume among individual concerns constitutes one of the most involved and difficult problems to be worked out for each industry.

What part shall the capacity of a given factory play in determining the share it shall receive of the total amount to be produced by the industry. Let us briefly study the accompanying table which portrays the problem of allotment when consideration is given to factory capacity.

	Maximum Capacity		*Average Past Sales*			*Allotment by Per Cent*	
Company	*No. of Units*	*% of Total*	*No. of Units*	*% of Total*	*% of Capacity*	*Based on Capacity*	*Based on Past Sales*
A	2,500	37.4	800	36.3	32.0	37.4%	36.3%
B	2,100	31.3	550	25.0	26.2	31.3%	25.0%
C	1,100	16.4	400	18.2	36.4	16.4%	18.2%
D	600	8.9	270	12.3	45.0	8.9%	12.3%
E	400	6.0	180	8.2	45.0	6.0%	8.2%
Total	6,700	100.0	2,200	100.0	..	100.0%	100.0%

The two large companies, in contrast with the three smaller ones, obviously would stress the need of factoring capacity to the largest per cent possible, while in contrast the other three would emphasize past sales as more important.

[7] See Church, A. Hamilton, *Overhead Expense*, McGraw-Hill Book Co., New York, 1930, pp. 209 and 213.

The setting of quotas is too new in practice to have evolved as yet any well recognized principles. Industries who are experimenting with the plan are still groping their way through trial and error.

An interesting formula has been recently considered by the manufacturers of folding paper boxes, which would give three times as much weight to sales history as to physical capacity, but with certain reservations to allow an independent referee to take account of the intangible factors of record for price maintenance, product appeal, and sales and service policies, as follows:

Folding Paper Box Industry
Proposed Formula for Quotas

	Weight
C = Physical Capacity Square inches of paper board cut and creased per hour, (rated impressions per hour multiplied by square inches of maximum size of sheet that can be fed into each cutting and creasing press).	25%
V = Sales Volume Average sales in dollars of folding paper boxes for five years from 1929 to 1933 incl., plus sales for year 1933; divided by two. If average sales of a particular member for five year period were a greater percentage of the industry than were his sales for 1933, his *trend is downward.* If his sales for 1933 were relatively greater, his *trend is upward.*	75%
Price Maintenance Each manufacturer's ratio to industry average trend from 1929 to 1933 of dollars of sales per thousand hours worked by factory workers (KMH).	
Product Appeal General record for development and research work and for improvement of designs to induce greater use of folding paper boxes, particularly for new and novel purposes.	
Sales and Service Effective sales management and creation of customer good will by prompt and reliable deliveries.	

$$\text{QUOTA} = \frac{C + 3V}{4}$$

Provided However:

If a member's *trend is downward* and his price maintenance record has been high, his quota may

APPLICATION OF FORMULA—FOLDING PAPER BOX INDUSTRY

	Company.....	*A*	*B*	*C*	*Total*
1.	Square inches cut and creased per hour—Rated capacity all presses.....	205 M sq. in.	185 M sq. in.	1218 M sq. in.	1608 M sq. in.
2	Each member's relative percentage of industry.....	12.74%	11.51%	75.75%	100.00%
3.	Sales of boxes—1929	$4,204	$	$49,239	$53,443
4.	Sales of boxes—1930	4,013		45,451	49,464
5.	Sales of boxes—1931	3,820		37,875	41,695
6.	Sales of boxes—1932	3,438	3,684	29,299	36,421
7.	Sales of boxes—1933	3,629	5,524	33,087	42,240
8.	TOTAL	$19,104	$9,208	$194,951	$223,263
9.	Average for five years	3,821	4,604	38,990	47,415
10.	Sales for 1933	3,629	5,524	33,087	42,240
11.	Sales volume—adjusted for quota $\frac{(L\ 9 + L\ 10)}{2}$....	3,725	5,064	36,038	44,827
12.	Substituted company "B's" volume (25% above 1933)*		6,905		
13.	Revised sales volume adjusted for quota.....	3,725	6,905	36,038	46,668
14.	Each member's percentage of sales volume.....	7.98%	14.80%	77.22%	100.00%
15.	Quota by formula $\frac{(L\ 2 + (L\ 14 \times 3)}{4}$.....	9.17%	13.98%	76.85%	100.00%

*Adjustment made to compensate for sales appeal of new and novel type of box brought out by company B in 1932.

be adjusted upward, but not to a percentage higher than his five year average, so far as his record for product appeal and for sales and services do not appear to the business manager to have been responsible for his loss of relative position.

If a member's *trend is upward* and his price maintenance record has been low, his quota may be adjusted downward, but not to a percentage lower than his five year average, so far as his record for product appeal and for sales and service do not appear to the business manager to have been responsible for his gain in relative position.

If a member's *trend is upward* and his record for product appeal and sales and service appear to the business manager to warrant unusual recognition, then the business manager may either set such member's quota at such percentage as in his judgment seems equitable, or may exclude such member's sales from quota computations until such time as his sales volume shall have become stabilized sufficiently to be used in regular computation of his quota.

A single illustration suffices here to show the effect of failure to recognize excess capacity. It must be obvious that if Company A has 12.74% of the physical capacity of the industry with a sales volume on only 7.98% (after recognizing the growing competition of Company B) it must be that Company A has not kept up with the procession of its competitors in selling its productive capacity. If it must now be content with 9.17% of the available business it will do well to look to the retirement or other disposition of its idle machinery.

IV—MEASUREMENT OF CAPACITY

Capacity, utilized and unutilized, may be conveniently measured in one or more of three ways, namely:

(1) physical output,
(2) productive effort,
(3) expenditure of money.

Physical Output

With a uniform product it is sometimes convenient to measure potential operating capacity, peak-demand capacity, normal capacity, and excess capacity in units of volume of output; barrels of flour in a flour mill; tons of rails in a steel mill; pounds of good castings in a foundry.

With a diversified product manufactured from a single raw material it is often expedient to measure capacity in units of raw material; pounds of wool in the grease in a woolen mill; number of animals slaughtered in a packing plant. Yet, again, the most practical measure may be found in some intermediate stage of conversion; tons of run of mine coal at the mouth of the shaft in a coal mine; gallons of pulp from the beaters in a paper mill.

The manufacture of paper egg cartons will be taken to illustrate the practical method of planning a simple one-unit enterprise in terms of physical volume of product. Prior to about 22 years ago eggs were uniformly packed and shipped in crates, 30 dozen to the crate, and when sold at retail were counted into a paper bag for delivery to the consumer. With the advent of better packaging of consumer goods, the paper egg carton appeared, to hold a half dozen or a dozen eggs. Its advantages over the paper bag were that it reduced breakage, facilitated counting the eggs, and, because it carried advertising, it met the prevailing expectations of the customer for an announcement of the worth of its contents. Two types of cartons were developed. One of these is used by the retailer to repack the eggs received by him in 30-dozen crates.

Their manufacture formerly was a five process operation, as follows:

(1) The carton boxes were printed on flat bed or cylinder presses on large sheets of cardboard.

(2) The printed sheets were cut into sizes of the flat carton stock and the trimming was stripped off by hand hammer.

(3) The carton blanks were fed into machines which set them up in box form and either glued or stitched the over-lapping sides or ends.

(4) The fillers, which go into the carton box to partition off the eggs from one another, were cut from rolls of cardboard, slotted, and interlocked all on one machine.

(5) The set-up box was knocked down by hand as it came from the gluer or stitcher, a filler was inserted, and the assembled cartons were packed in lots of 25.

Later machine developments have reduced to one operation the printing, cutting, setting up, gluing or stitching, and knocking down of the carton box, so it is now possible to feed the cardboard from rolls into one end of a machine and take away folded carton boxes

from the other. As they come from the box machine, fillers from the filler machine are inserted and the assembled cartons are packed as before.

Maximum Capacity

The aggregate physical output is controlled by whichever group of machines, under either method, has the lowest proportional volume of physical capacity. For example, if a factory equipped with one of the large, new style, automatic box machines, with a rated output of 140 boxes a minute, has three filler machines rated to turn out 50 a minute each or 150 a minute for the three, it is apparent that the filler machines overbalance the box machine in the ratio of $\frac{150}{140}$. So small a disparity might very well be absorbed in costs. But, if the factory has only two filler machines rated to turn out 100 a minute together, then the box machine would overbalance the filler machines in the ratio of $\frac{140}{100}$. In these circumstances the box machine could be utilized for only $\frac{100}{140}$ of its productive capacity and therefore $\frac{40}{140}$ of its fixed expenses should be classified as "Excess plant expense."

Actual tests in operation in one well-operated factory over a period of three years disclosed that when running full time the actual ouptut averaged 80% of the rated output. Potential operating capacity would therefore be 80% of the rated output of the "bottle neck" operation.

Normal Capacity

Not in recent years has any manufacturer of egg cartons been able to procure orders enough to permit of operating his machines at their maximum capacity. One typical manufacturer equipped to produce more than 30 million boxes a year has actually sold between 15 and 20 million in each of the five years from 1928 to 1932, inclusive. With present prospects what they are in this in-

MANUFACTURE OF EGG CARTONS

Equipment	Maximum Capacity Per Week	Peak Demand Capacity Per Week	Excess Capacity Per Week
2 box machines	537,600	400,000	137,600
1 shift, 40 hours per week @ 80% operating efficiency....	(100.0%)	(74.4%)	(25.6%)
7 filler machines	672,000	400,000	272,000
1 shift, 40 hours per week @ 80% operating efficiency....	(100%)	(59.5%)	(40.5%)
	Total per Week	Operating Expenses	Excess Plant Expenses
Allocated Machine Expenses			
2 box machines			
Depreciation of machinery	$61.54		
Depreciation of building	3.10		
Maintenance of machinery, equipment, and building; real estate taxes; and insurance	11.60		
	$76.24	$56.72	$19.52
	(100.0%)	(74.4%)	(25.6%)
7 filler machines			
Depreciation of machinery	$47.30		
Depreciation of building	2.60		
Maintenance of machinery, equipment, and building; real estate taxes; and insurance	9.62		
	$59.52	$35.41	$24.11
	(100.0%)	(59.5%)	(40.5%)
Total allocated machine expenses	$135.76	92.13	43.63

FIGURE 1

dustry it would seem wise for him to set his normal capacity at 15 million per annum, his peak demand capacity at 20 million, and to classify as "Excess plant expense" the fixed machine expenses attributable to all equipment in his shop beyond that required to produce 20 million.

Figure No. 1 on page 375 shows the division of expenses of plant devoted to the manufacture of egg cartons between operating expenses and non-operating expenses. The former, as has been said heretofore, will either be wholly absorbed in cost of product or go partly into "Volume Variance" when the plant is subnormally idle or supernormally busy. The latter will be deducted from income, as shown in Figure No. 4, on pages 386-87.

The box machines are rated at 140 per minute each, which would be at the rate of 672,000 a week. Deducting 20% to reduce output to average actual efficiency of 80% leaves 537,600 as maximum weekly capacity.

The required potential capacity of 20 million egg cartons per annum may be safely set at 400,000 a week, as that would allow of some short over-runs before requiring any overtime to yield the required annual total—enough to meet the weekly demand for this type of egg cartons, which are fairly uniform throughout the year.

A 400,000 potential capacity per week is only 74.4% of the present maximum physical capacity of 537,600. Therefore 25.6% of the allocated expenses of the box machines as shown below of $76.24, should be classified as "Excess plant expense," namely, $19.52.

The allocated expenses of the filler machines of $59.52 are likewise apportioned in part to "Excess plant expense" on the basis of their rated capacity of 50 per minute each.

Productive Effort

In a jobbing shop or factory converting diversified materials into a variety of products, there is no physical unit to provide a uniform measure. Here, except in the most highly mechanized processes all work is carried on under the control and volition of individual workers. For the most part, all mechanical apparatuses and all power distribution and control systems serve the purpose of increasing the skill and productivity of the worker. Hence it follows that all tools and equipment take their pace from him who uses them. They work when he works. They are idle when he is

idle. Therefore the standard direct labor hour (or fraction thereof) is the greatest common denominator of miscellaneous shop activities.

A machine shop in which various sizes of iron, steel, and brass castings are fitted for assembly into valves, pumps, and hydrants, which is equipped with machine tools some of which are listed in Figure No. 2 on pages 378-79, will be taken to illustrate the practical application of determining maximum, peak-demand, normal and excess capacities on the basis of productive men hours.

In the column headed Maximum Use, has been extended for each machine the number of hours per week it will be in use when the company's foundries are running at their maximum capacity, with six heats a week.

In the column headed Required Economical Use has been entered the number of hours per week each machine must be operated on the average when the foundries are running at their maximum capacity if the installation of the machine is to be justified as an economical tool. For example, the three engine lathes in Group No. 1, being standard machines of equal servicability, must be operated full time to warrant having them at all, while the Meriden forming lathe in Group 2, being a special duty machine, will justify its keep if it is in use half the time during which the shop is working.

In arriving at this required economical use for each machine consideration has been given to many factors. For one thing, alternative methods of producing the same results may bring up the required minimum use of machines above what their mere convenient use would entail. As Davenport says, in substance, in his *Economics of Enterprise,* costs for any activity cannot exceed those of another available method of attaining the same objective. As a striking example of this, we have the valve manufacturer's boring mill referred to on page 359, which must be used at least five hours a week to make its use economical enough to justify its installation as against even hand labor to do the same job. Competitive costs, both domestic and foreign, have a large influence on the required use of tools. Fixed expenses (interest on investment, depreciation, insurance, taxes, and a considerable part of maintenance) must be spread thinly enough when added to the differential expenses of operation (pay of operator, power, supplies, and

PRODUCTIVE MAN HOURS OF MACHINE TOOL USE—WEEKLY

Machine Number	Description	Maximum Use	Required Economical Use	Peak Demand	Excess Mach. Time	Normal Use
	Group No. 1					
101	American Engine lathe 18" x 12"	40	40	24	16	18
109	American High Duty lathe 18" x 12"	40	40	24	16	18
110	American High Duty lathe 16" x 12"	40	40	24	16	18
		120	120	72	48	54
	Group No. 2					
305	Meriden Forming lathe 13"	30	20	10	10	8
	Group No. 3					
308	American Turret lathe 24"	36	24	18	6	14
309	American Turret lathe 24"	20	24	10	14	7
		56	48	28	20	21
	Group No. 4					
311	Fay & Scott lathe 18"	40	40	16	24	14
312	Fay & Scott lathe 18"	40	40	16	24	13
314	Fay & Scott lathe 18"	24	40	0	40	0
322	Fay & Scott lathe 18" x 6"	40	40	40	0	27
		144	160	72	88	54

	Group No. 5					
315	Dresser lathe 20"	72	40	36	4	27
	Group No. 6					
316	Gisholt lathe 20"	40	40	24	16	18
317	Gisholt lathe 20"	40	40	24	16	18
318	Gisholt lathe (Style H) 21"	24	40	12	28	9
319	American lathe 24" x 32"	24	40	12	28	9
320	Libby lathe 26"	60	40	30	10	23
325	Gisholt lathe 21"	60	40	30	10	22
351	Libby lathe (Type A) 18" x 16' 8"	60	40	30	10	23
352	Libby lathe (Type A) 18" x 16' 8"	60	40	30	10	22
		288	240	144	96	144
	Group No. 7					
328	Acme Flat Turret lathe 3½" x 36"	44	40	40	0	22
329	Acme Flat Turret lathe 3½" x 36"	40	40	0	40	0
337	Acme Flat Turret lathe 3½" x 36"	40	40	22	18	18
338	Acme Flat Turret lathe 3½" x 36"	40	40	40	0	23
339	Acme Flat Turret lathe 3½" x 36"	40	40	0	40	13
		204	200	102	98	76

FIGURE 2

wear and tear) to produce a competitive cost per productive hour.

The probabilities are that as time goes on the minimums here shown will have to be increased because competition, even in absence of control by law, will force recognition of the fact that, with an apparently permanent over-supply of labor the use of machinery tends to become more intensive. Two, three, and four shifts a day are increasing. Moreover, in operations where individual craftsmanship has become superseded by machine or tool improvements their continuous use is essential to crowd their full economical usefulness into their potential economic life, for we may be sure that they will be outmoded by more skilfully designed apparatus long before they break down under the strain of wear and tear.

In the column headed Peak Demand has been entered for each machine the estimated number of hours per week it will be in use to meet maximum commercial demands for the products of the plant.

In the column headed Excess Machine Time has been entered the number of hours per week each machine's operating time during peak demands on the shop falls short of its required economical use.

In the column headed Normal Use has been entered the number of hours per week each machine will be in use to meet average demands, as determined by past experience modified to take account of changing trends in the company's industry, and by the probable average future consumption of the company's products as forecast from market surveys.

Excess plant expense is the amount by which lowest attainable machine and equipment expenses exceed economical costs, and may be computed as the percentage of budgeted plant expenses by which required economical use exceeds peak demand use, if any.

An illustrative computation is shown in Figure No. 3 on pages 382-83.

In Figure No. 3, which deals with machine tool group No. 1 from Figure No. 2, the required economical use per week for each lathe is shown as full time of 40 hours. Peak demand use of 24 hours a week, leaves 16 hours as excess capacity. Simply enough then, 24/40 (or 72/120) of the weekly machine tool expense of $34.74 for depreciation, maintenance, taxes, and insurance is

chargeable to operating expenses and the remainder to non-operating expenses, i.e., to Excess Plant Expense. Objection might be raised to charging Excess Plant Expenses with any part of the expense for maintenance which is necessitated by wear and tear, but the objection may be disregarded as academic until better data are available than now obtain to prove to what extent, if at all, average maintenance expenses are increased by the degree of use of an operated machine.

On the other hand, interest on investment has not been included as an element of expense because the weight of authority, as yet at least, lies against its inclusion in operating costs.

Hourly machine tool expense for costing use is derived by dividing the part of machine tool expense allocated to operating expenses, namely $20.84, by the normal weekly use of these machines, namely 54 hours, and adding to this fixed expense per hour of .40 the average hourly differential expenses for power and operators of .094 and .54 respectively, and also the average hourly charge for normal supervision and other factory overhead distributed on the basis of standard productive hours, namely, .675. The whole produces an aggregate of $1.71 per productive hour for computing the standard cost of each unit of product machined on any one of these lathes, according to the number of hours or fractions of hours allowed for the operation.

It may be noted in passing that since the cost for power varies as among these three lathes an opportunity for economy in his actual operation is open to the shop superintendent through preferential use of the more economical machine when other considerations are equal.

V.—EVALUATION OF CAPACITY

By whatever unit plant capacity is measured, its conversion into terms of money is immediately essential for accounting expression, so that it may be entered into cost of product when in use, and when idle be excluded from costs and set-up either as Volume Variance or Excess Plant Expense.

Figure No. 4, on pages 386-87, shows the several points on the Income Statement where the cost of used or idle capacity should appear, as follows:

(a) *Cost of Sales Billed* includes the standard cost of proces-

CLASSIFICATION OF MACHINE TOOL TIME AND DIVISION OF MACHINE TOOL EXPENSE BETWEEN STANDARD COSTS AND EXCESS PLANT EXPENSE

GROUP No. 1

Mach. No.	Description	Max. Use Per Week (Hours)	Min. Economical Use Per Week (Hours)	Peak Demand Per Week (Hours)	Excess Capacity (Hours)	Normal Use Per Week (Hours)
101	American Engine lathe 18" x 12"	40	40	24	16	18
109	American High Duty 18" x 12"	40	40	24	16	18
110	American High Duty 16" x 12"	40	40	24	16	18
		120	120	72	48	54

Machine Tool Expense—weekly	Total	Standard	Excess
Depreciation of machinery	$17.62		
Depreciation of building	.99		
Maintenance of machinery, equipment, and building; real estate taxes; and insurance; and watchmen	16.13		
Total weekly expense	$34.74		
Apportionment to standard cost 72/120 of $34.74		$20.84	
Remainder to excess plant expense			$13.90
Machine Tool Expense—hourly			
Apportionment of weekly expense $20.84 a week ÷ 54 normal hours a week		$ .40	

	Power		
101	D.C. 204 K W @ $.045 per K W H.....	.0918	
109	A.C. 230 K W @ .033 per K W H.....	.0759	
110	D.C. 255 K W @ .045 per K W H.....	.11475	.094 (Average)
	Direct labor pay per standard productive hour.....		.54
	Supervision and other overhead distributed on basis of standard productive hours.....		.675
	Standard processing cost per productive hour.....		$1.709

FIGURE 3

sing the output actually shipped out and billed to customers during the month. This standard cost for each unit of production has been derived from dividing standard output into standard expenditures at normal activity, i.e.,

Standard Labor Cost plus Allocated Standard Machine Expense plus Distributed Standard Shop Overhead divided by Standard number of production units	=	Standard Processing Cost per unit.

from which follows:

Standard Processing Cost per unit plus Standard Material costs per unit	Multiplied by No. of units billed,	=	Cost of Sales Billed

If the actual manufacturing processes all occurred in the same month when the product was billed out there has been no holdover of manufacturing costs. If they occurred wholly or partly in previous months then, to that extent, such costs have in the meantime been carried in inventory under Work in Process or Manufacturing Stock.

(b) *Volume Variance:* The difference between the standard cost of processing the actual production of the current month, and the total budget of allowed machine expenses and other shop overhead expenses for the current month, is included under (b) Volume Variance, except for

(c) *Excess Plant Expense,* which is the amount, if any, that is appropriate to deduct from the current month's budget to cover maintenance, depreciation, insurance, taxes, and other differential expenses, if any, allocatable to excess plant, and which is set up under (c) Excess Plant Expense.

The journal entries at the end of this article give an outline of the bookkeeping steps by which the accounting returns on Figure 4 are recorded.

VI.—PLANT CAPACITY AND PROFITABLE OPERATIONS.

In the income statement presented in Figure 4 we have before us an illustration of the relative effects on profit possibilities of all fac-

tors for a particular enterprise. This permits of viewing the expenses of unutilized plant in proper perspective.[8]

The basis of normal activity is shown as 75% of operating capacity. As has been said, this must represent the average operating ratio of "bottleneck" processes. With this as the normal basis, it is probable that peak demands would require 100% activity. As a matter of fact the records show that in 1928, when past operations reached their maximum, the plant was working on a 54-hour week, and even at that had frequently to work overtime to make required deliveries. But 1928 demands are not likely to repeat themselves in this particular industry, so far as seems probable from prospects now in sight. Even if they do, the present 40-hour week will not be abandoned. The plant will merely work double shifts, so far as overtime is either not permissible or not desirable. Viewed from this standpoint a survey of the machinery and equipment discloses two types of excess idle capacity. First, there are machines in every department that would be used only as a makeshift, because they are uneconomical and inefficient. For the most part their cost has been written off the books by past depreciation accruals. So far as they are insured it is merely in hopes of a fire. The premium is just a bet with the underwriters, with long odds against the industry. It should not be included in the operating expenses of the factory. If all this antiquated junk were out of the way it should be possible to reduce the present expense for plant watchmen and obtain a reduction in the tax assessment on the property. Better a great deal scrap the whole lot once and for all. The space these machines occupy will be put to better use when they are gone, and the temptation to put them back into operation in emergencies will give place to more economical planning of the work, either by more intensive use of the better facilities remaining, or by preparing to buy new if the hoped for needs should ever arise.

Second, many of the machines that were added to the plant's facilities during recent years were bought in the confident belief in a "New Economic Era," in which each year would bring new and widened demands for the plant's products. As a result each

[8]For a full discussion of other factors on this statement see the author's article "Costs and Expenditures," *Factory and Industrial Management*, 330 W. 42nd St., New York, N. Y., September, 1932.

INCOME STATEMENT

	Basis of Current Budget	—BUDGET— Normal	—BUDGET— Current Period	ACTUAL Current Period	Over or Under Current Budget	Ratio to Standard
Ratio of current operations to capacity		75%	30%	32.7%	2.7%	109.0%*
Gross sales billed	Forecast	200,000	80,000	84,960.17	4,960.17	106.2%
Deductions from Gross Sales:						
Returns and allowances	Standard	1,900	760	841.16	81.16*	90.3%*
Freight on sales	Standard	5,000	2,000	1,962.10	37.90	102.0%
Total Deductions		6,900	2,760	2,803.26	43.26*	98.5%*
Net Sales billed		193,100	77,240	82,156.91	4,916.91	106.4%
a. Cost of sales billed	Standard	117,500	47,000	49,980.10	2,980.10	100.0%
Gross Profit		75,600	30,240	32,176.81	1,936.81	106.4%
Deductions from Gross Profit:						
Administration expenses	Schedule	16,000	9,293	11,618.70	2,325.70*	80.0%*
Sales expenses	Schedule	21,500	12,950	13,911.10	961.10*	93.1%*
b. Volume variance	Forecast	.....	16,780	13,694.10	3,085.90	122.5%*
Factory overhead variances		.....	.....	2,612.64	2,612.64*	91.8%*
Unbudgeted expenses		.....	.....	1,814.60	1,814.60*	0.0%*
Labor variances		.....	.....	1,275.19	1,275.19*	92.5%*
Material quantity variances		.....	.....	207.20	207.20*	99.0%*
Inventory variances		.....	.....	320.16	320.16*	0.0%*
Material price variances		.....	.....	36.18	36.18*	99.9%*
Total Deductions		37,500	39,023	45,489.87	6,466.87*	85.8%*
Income from Operations		38,100	8,783*	13,313.06*	4,530.06*	66.0%*

Other Income:						
Investment income	Forecast	235	94	62.10	31.90*	66.1%
Rent from properties	Schedule	1,000	160	200.00	40.00	125.0%
Cash discounts on purchases	Standard	960	810	810.00	.....	.....
Total Income		40,295	7,719*	12,240.96*	4,521.96*	63.1%*
Deductions from Income:						
Cash discounts on sales	Standard	1,300	520	617.80	97.80*	84.2%*
Rents for properties (net)	Schedule	60	60	60.00	.....	.....
c. Excess plant expense	Schedule	1,640	1,640	1,640.00	.....	.....
Interest on debt	Standard	3,000	3,000	3,000.00	.....	.....
Total Deductions		6,000	5,220	5,317.80	97.80*	97.7%*
Net Income		34,295	12,939*	17,558.76*	4,619.76*	72.1%*

Note: Asterisk (*) indicates unsatisfactory results.

This treatment of idle plant expense as Volume Variance, and of other variances from managerial standards need not be carried into stockholders' and other outside reports. A management is under no obligation to publish the extent by which it exceeds or falls short of its own self-imposed objectives. For publication, "Costs of Sales Billed" may appropriately absorb all operating variances.

FIGURE 4

new machine's capacity was designed to synchronize not with the rest of the equipment of the shop but with an enlarged output to which, through the process of replacement, the remainder would eventually catch up. Since no such program of expansion is now in contemplation we find an unbalanced condition, the only remedy for which is to exclude from costs and classify as Excess Plant Expense the amount of depreciation, insurance, maintenance, and taxes on all this recently purchased equipment so far as this amount exceeds what it would be if these machines were of no greater capacity than they need be to fit in with the productive capacity of the rest of the shop.

It might even be sound to go a step farther and throw out of our costs all elements of expense which must be excluded to bring them down to the level of the lowest reasonable costs in the industry, but if this were done the entire amount so excluded should be labeled Excessive Plant Expense rather than merely Excess Plant Expense. Better still to call it Excessive Operating Expenses. After all, nicety of terminology in classification makes for clear thinking, in lieu of fuzzy ideas of accounting.

The relatively small amount of $1,640 shown on this statement as Excess Plant Expenses, might seem of little importance in relation to the much larger items on the statement which are interposed between Gross Profit and Net Income. Two considerations, however, forbid dismissing this $1,640 as negligible. In the first place, it stands as evidence of physical conditions that are a drag rather than a help to the business. Secondly, the amount itself is not insignificant. It is enough to pay interest for the month on over $300,000 of borrowed or invested capital, which indicates at least that much misdirected financing in the management of the property, a part of which it may not be too late to divert to profitable use.

The much larger figure of $16,780 shown on the statement for Volume Variance, under the current budget, represents the cost of idle capacity which must be carried through this period of depression in order to have it available to meet the probable needs of the near future as we now foresee them. It includes not merely the standby expenses, of maintenance, depreciation, insurance and taxes on our present abnormally idle equipment, but also all other overhead such as the salary payroll, which is sufficient to handle

more than double the business we have today and cannot be reduced to keep step with the volume to which our business has now shrunk. In only two ways can this burden of unproductive expenditure be reduced. First, by rebudgeting to bring about an actual lessening of the amount, which may be not only difficult but also unwise, and even perhaps impossible. Second, by increasing sales. This way lies the salvation of this business, and every other. All past experience leads us to believe that sooner or later general business activity will improve. For those who are content to ride with the tide there is nothing to do but wait. Such an attitude, however, presupposes that business ebbs and flows with celestial influences over which man has no control. If a more dynamic approach be taken to the sales problems of a particular enterprise, the first essential consideration is usually the question of competitive prices. Prices as we have seen are derived from the interplay of many factors.

Our case study here presented should indicate the weight to be given to the need for absorbing those continuing expenses which are carried as a result of plant capacity. "They also serve who only stand and wait," but readiness-to-serve costs money. A fine sense of merchandising values is needed to estimate to what degree sales can be increased by price reductions in order to balance off the resulting increase in revenues against the decrease in revenues that may follow the reduction in general market prices that tends to follow every price concession. It is a misdirected policy to attempt to reach marginal purchasers by reducing prices if no more idle plant expense is taken up than the loss of revenue such reductions bring us on the business we have already. Capacity represents investment in the industrial enterprise. In the final analysis profits or losses are always expressed as plus or minus returns on that capacity investment. Sales may be considered good and adequate and yet may result in a loss. Too few sales at too high a price may be just as profitless as too many sales at too low a price. After all it is plant capacity we are selling and management's problem is how to make the most of it, through good times and bad.

JOURNAL ENTRIES

Journal Voucher No. 1

19			
Jan. 31	Factory Operations	48,146.61	
	Current month's accounts payable for expenditures for operations of the factory.		
	Administration Expenses	11,618.70	
	Current month's accounts payable for expenditures for administration expenses.		
	Sales Expenses	13,911.10	
	Current month's accounts payable for expenditures for sales expenses.		
	Manufacturing Stock	30,600.00	
	Current month's accounts payable for raw materials, taken into stock at standard prices.		
	Material Price Variances	36.18	
	Net difference between cost of raw materials for manufacture at standard prices and at actual invoice prices.		
	Accounts Payable		104,312.59
	Distribution of accounts payable audited and registered during current month.		

Journal Voucher No. 2

	Work in Process	27,110.08	
	Current month's processing costs at standard rates for each operation.		
	Volume Variance	13,694.10	
	Difference between standard cost of current month's processing and current month's factory operation budget, after excluding therefrom the amount chargeable to Excess Plant Expense.		
	Excess Plant Expense	1,640.00	
	Current month's budget for maintenance, depreciation, insurance premiums, and taxes assignable to excess plant capacity.		
	Factory Overhead Variance	2,612.64	
	Difference between current month's factory overhead budget and actual expenditures for factory overhead expenses, after excluding therefrom amounts chargeable to Unbudgeted Expenses.		
	Unbudgeted Expenses	1,814.60	
	Extraordinary and non-recurring factory overhead expenses that were not anticipated in budget allowances.		
	Labor Variances	1,275.19	
	Differences between standard labor costs allowed for processing current month's production and direct labor payroll (due principally to excess allowances paid to labor for time allowed to meet guarantee of prevailing day's wages on hard and difficult work and variances from standard rates of pay).		
	Factory Operations		48,146.61

Distribution of current month's expenditures for operations of the factory.

JOURNAL VOUCHER No. 3

Manufacturing Stock	24,198.27	
Work in Process		24,198.27

Standard cost of processing jobs completed and delivered to storekeeper during month.

JOURNAL VOUCHER No. 4

Material Quantity Variances	207.20	
Manufacturing Stock		207.20

Difference between standard cost of allowed quantities of materials processed during current month and standard cost of actual quantities used.

JOURNAL VOUCHER No. 5

Inventory Variances	320.16	
Work in Process		81.14
Manufacturing Stock		239.02

Differences between book balances and actual quantities of materials on hand at end of current month as disclosed by physical inventories.

JOURNAL VOUCHER No. 6

Cost of Sales Billed	49,980.10	
Manufacturing Stock		49,980.10

Standard cost of current month's sales.

JOURNAL VOUCHER No. 7

Accounts Receivable	84,960.17	
Gross Sales Billed		84,960.17

Invoices rendered for current month's sales.

JOURNAL VOUCHER No. 8

Cash Discounts to Customers	617.80	
Accounts Receivable		617.80

Discounts deducted by customers from payments of invoices made within cash discount period.

JOURNAL VOUCHER No. 9

Returns and Allowances	841.16	
Accounts Receivable		841.16

Credit memorandums issued to customers during current month.

JOURNAL VOUCHER No. 10

Freight on Sales	1,962.10	
Accounts Receivable		1,962.10

Freight and other transportation charges deducted by customers from payments of invoices for merchandise sold on delivered basis.

Accumulation of current month's entries to profit and loss accounts to prepare income statement.		
Gross Sales Billed		84,960.17
Cash Discounts to Customers	617.80	
Returns and Allowances	841.16	
Freight on Sales	1,962.10	
Cost of Sales Billed	49,980.10	
Administration Expenses	11,618.70	
Sales Expenses	13,911.10	
Volume Variance	13,964.10	
Factory Overhead Variances	2,612.64	
Unbudgeted Expenses	1,814.60	
Labor Variances	1,275.19	
Material Quantity Variances	207.20	
Inventory Variances	320.16	
Material Price Variances	36.18	
Excess Plant Expense	1,640.00	

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